A CLOTHES DRYER
[Irui kansoki]

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1. Title of the Invetion

    A Clothes Dryer

2. Claims

    A clothes dryer comprising a drum housing clothing; a blower blowing hot air into the drum; sensors, each of which detect, respectively, the temperature of the air intake side of the drum and the temperature of the exhaust side; and a microcomputer controlling the operation relative to the difference of the output from each sensor; each sensor is configured from a diode, and the clothes dryer is provided with a constant-current circuit providing a constant current to each of the diodes, and with a comparator circuit outputting the difference between the terminal voltages from each of the diodes when a specified value is surpassed; output from the comparator circuit is sent to the microcomputer.

3. Detailed Explanation of the Invention

(A) Industrial Field of Application

    This invention concerns a clothes dryer drying clothing with warm air.

(B) Prior Art

    Prior clothes driers of this type are provided with a drum housing clothing; a blower blowing warm air into the drum; thermistors, each of which detect, respectively, the temperature of the air intake

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[*]Numbers in the margin indicate pagination in the foreign text.

side of the drum and the temperature of the exhaust side; and a microcomputer inputting the temperature detected values obtained from each thermistor. The microcomputer calculates the difference of each of the inputted temperature detected values and operates the clothes dryer until the difference attains a specified value.

(C) Problems that the Invention is to Solve

Prior clothes dryers of this type, however, compared within the microcomputer the differences between the temperatures detected by each sensor. Because the microcomputer programs calculated the operational temperature times corresponded to those differences, and since they controlled the operation of the clothes dryer, their complexity proved to be problematic. The thermistor used for the sensor, moreover, is a comparatively expensive component.

This invention takes these conditions into consideration and offers a clothes dryer that utilizes an inexpensive component for the sensors and allows for the simplification of the microcomputer /520 program.

(D) Means of Solving the Problems

This invention is a clothes dryer comprising a drum housing clothing; a blower blowing hot air into the drum; sensors, each of which detect, respectively, the temperature of the air intake side of the drum and the temperature of the exhaust side; and a microcomputer controlling the operation relative to the difference of the output from each sensor; each sensor is configured from a diode, and the

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clothes dryer is provided with a constant-current circuit providing a constant current to each of the diodes, and with a comparator circuit outputting the difference between the terminal voltages from each of the diodes when a specified value is surpassed; output from the comparator circuit is sent to the microcomputer.

(E) Operation of the Invention

The diode has a characteristic of changing the terminal voltage via alterations in temperature when a constant current is supplied thereto. The diode can therefore be used as a sensor when this characteristic is utilized. Supply a constant current to each diode via a constant current circuit and the terminal voltage therefor changes in accord with the temperature of the air intake side of the drum and the temperature of the exhaust side. A comparator circuit outputs a signal to a microcomputer when the differences in temperature attain a specific value. The microcomputer may then suspend operating the clothes dryer at the moment the signal is inputted, disallowing the necessity of its making comparative calculations between differences in detected temperatures and specified values, thereby simplifying the microcomputer program.

(F) Working Example

This invention will be explained in detail below based on the working example shown in the drawings. The invention is not restricted to this explanation.

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Figure 1 is an electrical circuit diagram illustrating one working example of this invention. (1) is a microcomputer; (2) a fan motor blowing air upon clothing to be dried; and (3) a heater heating the air blown by the fan motor (2). Output from the microcomputer (1) controls each of these components. (D1, D2) are diodes installed for detecting, respectively, the temperature of the air intake side and the temperature of the exhaust side of the drum (not shown) housing clothing. (R1, R2) are resistors connecting in parallel each of the diodes (D1, D2) to a power supply terminal (V). The resistance value of both is equally sufficiently great in comparison to the forward resistance of the diodes (D1, D2), and this accounts for a nearly constant current being supplied from the power supply terminal (V) to the diodes (D1, D2). (OP1, OP2) are operational amplifiers, (R3, R4, R5, R6) are resistors, and these configure a differential amplifier inputting terminal voltage (V1, V2) for the diodes (D1, D2). Now, these are set so that R4=R5=RA and R3=R6=RB, therefore the output (E1) is expressed as:

$$E1 = (1 + RB/RA)(V1 - V2) \ldots (1)$$

(R7, R8) are resistors dividing the voltage supplied from the power supply terminal (V). (OP3) compares voltage (E2) divided via the resistors (R7, R8) and the output (E1) of the operational amplifier (OP2). Output (E3) from the operational amplifier (OP3) switches from High to Low when E1 becomes higher than E2. (R9) is a resistor that

brings about hysteresis characteristics in the operational amplifier
(OP3).

Figure 3 is a graph representing the relation of forward current
(IF (mA)) to the forward voltage (VF (V)) of the diodes (D1, D2) with
ambient temperature (Ta) as the parameter. Accordingly, when, for
instance, IF = 1 mA, the ambient temperature changes from -50°C to
+50°C, the terminal voltage of the diodes (D1, D2) changes to
approximately 200 mV, and the temperature characteristic will be
approximately -2 mV/°C.

In this configuration the microcomputer drives the fan motor (2)
and the heater (3). The temperature of the air intake side and the
temperature of the exhaust side of the drum are detected, respectively,
by the terminal voltages (V1, V2), and the differences are calculated
by the (1) formula when drying of the clothes is initiated. The
operational amplifier (OP3) compares the voltages (E1, E2); when E1
surpasses E2, output (E3) from the operational amplifier (OP3)
switches from High to Low and is inputted to the microcomputer. The
microcomputer (1) receives the change in output (E3) from the
operational amplifier (OP3), determines that the clothes are dried,
and suspends driving the fan motor (2) and the heater (3) to conclude
the clothes drying process.   /521

In this instance the voltage (E2) is set via the voltage
resistance dividers (R7, R8). Nonetheless, if, for example, a

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variable resistor is utilized to freely allow changes in voltage (E2),
then the clothes drying process can be freely set via the voltage (E2).

Figure 2 is an electrical circuit diagram illustrating another
working example of this invention. R10 and R1 are series resistors
connecting a diode (D2) to the power supply terminal (V) and their
resistance value is set such that R10 + R11 = R1. OP4 is an
operational amplifier comparing the differences between the terminal
voltage (V1) of the diode (D1) and the terminal voltage (V3) of a
series circuit for the diode (D2) and the resistor (R10). The rest of
the configuration is equivalent to that of Figure 1.

In this type of configuration the microcomputer (1) runs the fan
motor (2) and the heater (3). When initiating the operation of the
dryer, V1 and V2 are at first equal, for which reason the input (V3)
of the operational amplifier (OP4) only elevates the terminal voltage
distribution of the resistor (R10) while the output of the operational
amplifier (OP4) is maintained at High. Drying of the clothes then
proceeds. When the temperature of the exhaust side of the drum
surpasses that of the air intake side, and when the terminal voltage
(V2) of the diode (D2) steadily decreases becoming lower than the
terminal voltage distribution of the resistor (R10), the voltage (V3)
becomes lower than V4 and the output of the operational amplifier (OP4)
changes from High to Low. The microcomputer (1) receives this change,
determines that the clothes are dried, and suspends driving the fan
motor (2) and the heater (3) to conclude the clothes drying process.

In this instance as well, R11 and R10 configure, for example, a variable resistor, allowing for setting the degree of dryness for the clothes as a matter of course.

(G) Effects of the Invention

This invention allows for using a diode as a temperature sensor, which makes it inexpensive. Moreover, it is no longer necessary for the comparison operations control to occur in the microcomputer, which simplifies the microcomputer program.

4. Brief Explanation of the Drawings

Figure 1 is an electrical circuit diagram illustrating one working example of this invention; Figure 2 is an electrical circuit diagram illustrating another working example of this invention; and Figure 3 is a graph showing the forward voltage – forward current characteristics of the diodes used in the present invention when the ambient air temperature is changed.

1... Microcomputer; 2... Fan motor; 3... Heater; D1, D2... Diode; R1–R9... Resistor; OP1–OP3... Operational amplifier.
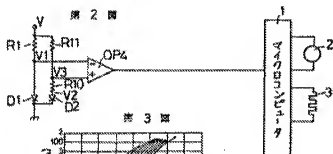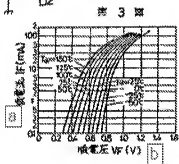
Figure 1

第 1 図
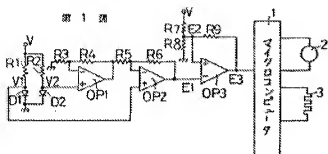
1) Microcomputer

Figure 2

第 2 図

1) Microcomputer

Figure 3

第 3 図

Key:
a) Forward current IF(mA);
b) Forward voltage VF(V)